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March 31, 1994

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SUBJECT: RADIOACTIVITY CONTROLS IN PROTOTYPE PLANTS AT THE NAVAL REACTORS FACILITY

Since implementation of the federal facility agreement and Consent Order (FFA/CO), both State and EPA Waste Area Group (WAG) Managers have expressed a interest to become more familiar with the process of controlling radioactivity in the prototypes at the Naval Reactors Facility (NRF) to support WAG Manager decisions.

To assist WAG Managers in understanding this process, a summary of radioactivity controls in the prototype plants at NRF has been prepared and is being forwarded for your information (attached). The same philosophy and rules are applied throughout NRF, including at ECF.

If you have any questions about the attached document, please feel free to contact me at (208) 533-5243.

R. Dary E. Newbry
WAG-8 Project Manager

Attachment:
As stated

cc: M. Sekot, AR/IR (10)

Attachment to:
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SUMMARY OF CURRENT RADIOACTIVITY CONTROLS IN NAVAL NUCLEAR PROPULSION PROGRAM PROTOTYPE PLANTS

Control of radiation and radioactivity associated with Naval nuclear propulsion plants is of paramount importance to the U.S. Naval Nuclear Propulsion Program, since the personnel operating the nuclear reactors on board U.S. Navy warships must live for months at a time in close proximity to the reactors. The Programs's design and operating philosophy is to control radioactivity at its source. One measure of the effectiveness of this philosophy is the fact that while at sea, a typical nuclear powered submarine crew member receives less radiation exposure than he would have received from naturally occurring sources of radioactivity had he remained on shore. Naval Nuclear Propulsion Program prototype plants at the Naval Reactors Facility are land-based prototypes of the reactor plants used in U.S. Navy ships, and are designed and operated to the same standards.

Naval Nuclear Propulsion Plant Description:

Both shipboard and prototype reactors use a pressurized water reactor design which has two basic systems: the primary system and the secondary system. The primary system circulates ordinary water in an all-welded, closed loop consisting of the reactor vessel, piping, pumps, and steam generators. The heat produced in the reactor core is transferred to the primary system water, which is kept under pressure to prevent boiling. The heated water passes through the steam generators where it transfers its energy. The water is then pumped back to the reactor to be heated again.

Inside the steam generators, the heat from the primary system is transferred across a water-tight boundary to the water in the secondary system, also a closed loop. The secondary water, which is at lower pressure, boils, creating steam. Isolation of the secondary system from the primary system prevents water in the two systems from intermixing, keeping radioactivity out of the secondary water. Frequent monitoring of the secondary water for radioactivity verifies the continued integrity of the water-tight boundary.

In the secondary system, steam flows from the steam generators to drive the main propulsion turbines, which turn the ship's propeller, and the turbine generators, which supply the ship electricity. After passing through the turbines, the steam is condensed back into water and pumped back to the steam generators for reuse. On a ship, the heat removed from the condensing steam is transferred to the sea via a sealed heat exchanger. For the prototype plants, the sea is simulated by circulating water cooling systems. This third system, which includes cooling towers, receives the heat from the secondary system steam, and dissipates it in the atmosphere. Thus, for prototype propulsion plants, the primary, secondary systems, and circulating water cooling systems are separate systems in which constantly circulating water transforms the energy produced by the nuclear reaction into useful work. A typical Naval nuclear prototype propulsion plant is shown in Figure 1.

Primary System Coolant Radioactivity:

The principal source of radioactivity in primary system coolant is trace amounts of corrosion and wear products from reactor plant metal surfaces in contact with reactor cooling water. Radionuclides with half-lives of approximately one day or greater in these corrosion and wear products include tungsten-187, chromium-51, hafnium-181, iron-59, nickel-63, niobium-95, zirconium-95, tantalum-182, manganese-54, cobalt-58, and cobalt-60. The most predominant of these is cobalt-60, which has a 5.3 year half-life. Cobalt-60 also has the most restrictive concentration limit in water as listed by organizations which set radiological standards for these corrosion and wear radionuclides. Therefore, cobalt-60 is the primary radionuclide of interest for Naval nuclear propulsion plants.

Fission products produced in the reactor, including iodine and the fission gases krypton and xenon, are retained within the extremely high-integrity fuel elements (such high integrity is needed to isolate the fission products from the crew). The continued integrity of the fuel is verified through regular analyses of primary system coolant samples using sensitive detection equipment. The sensitivity is so low that the analyses routinely detect the trace levels of fission products released from the minute quantities of naturally occurring uranium impurities in reactor structural materials. The concentrations of these trace levels of fission products comprise only a small fraction of the corrosion and wear products.

Primary system coolant also contains short-lived radionuclides with half-lives of seconds to hours. However, these short-lived radionuclides are not important since the concentration of the longest-lived of them is reduced to one thousandth of the initial concentration one day after removal from the primary system, and one millionth two days after removal. These short-lived radionuclides essentially decay in place in the primary system.

Occasionally, certain prototype operations such as start-up and sampling require the discharge of small quantities of water from the primary system. However, all of the primary water discharged from the prototype propulsion plants is collected and processed for reuse through a purification system consisting of filters, activated carbon, and ion exchange resin. Because of the effectiveness of this reuse program, there is no need to discharge primary system coolant to the environment.

Non-radioactive Effluents:

Since the water in both the secondary and circulating water cooling systems is physically isolated from water in the primary system, no radioactivity is transferred to that water. As a result, only non-radioactive secondary and circulating system water is released when excess water is discharged from an NRF prototype plant to the NRF site drainage ditch.

Environmental Monitoring:

Control of radioactive materials and radioactivity has been closely monitored since the beginning of the Naval Nuclear Propulsion Program to provide additional assurance that procedures used are adequate to protect the environment. NRF has maintained an environmental and effluent monitoring program that includes sampling effluents for radioactivity at the point of discharge as well as sampling water in the ditch itself. Results of this monitoring program indicate that operations at NRF have not had any significant adverse impact on the levels of radioactivity naturally occurring in the environment.

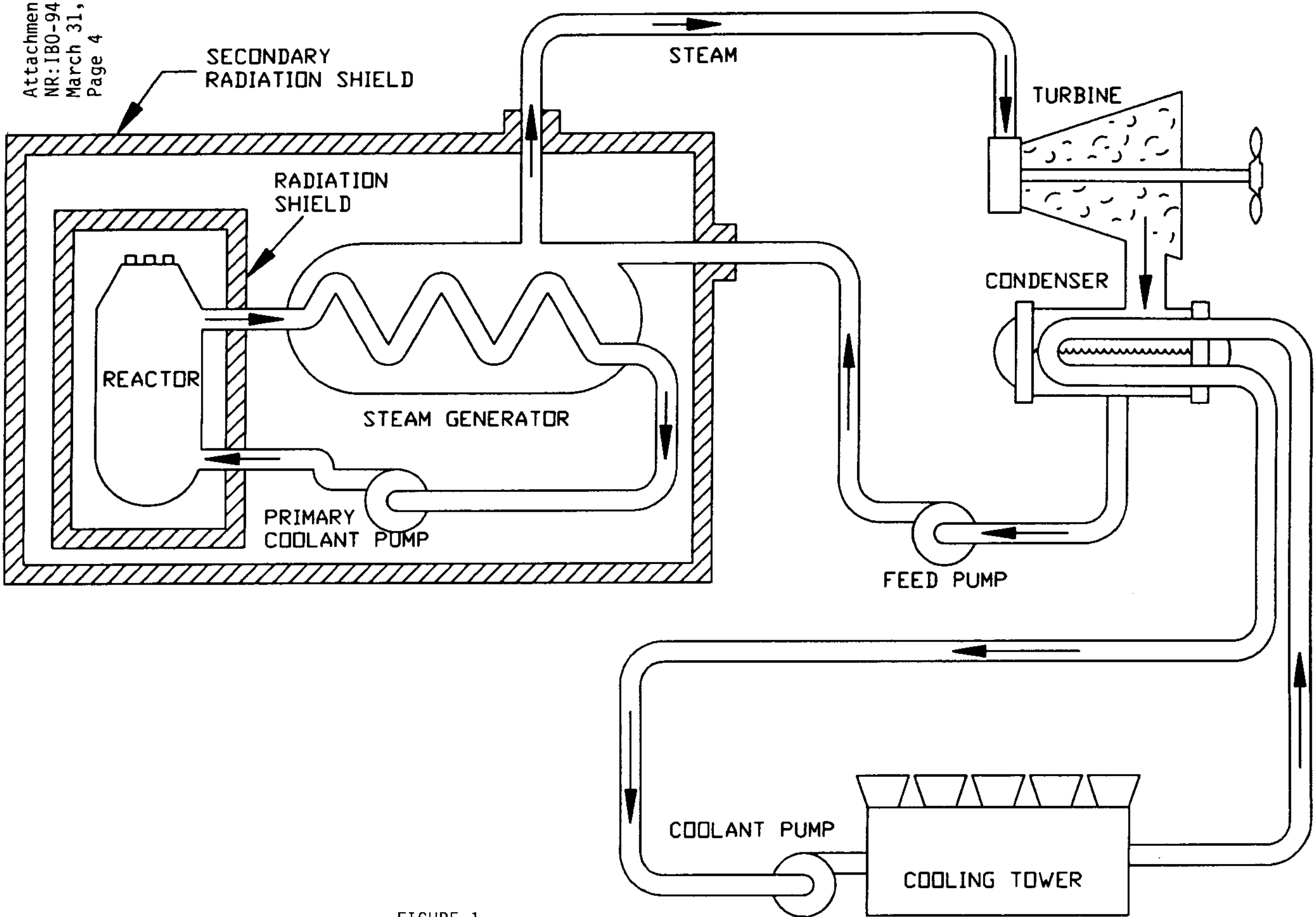
SECONDARY
RADIATION SHIELD
RADIATION
SHIELD
REACTOR
STEAM
STEAM GENERATOR
PRIMARY
COOLANT PUMP
TURBINE
CONDENSER
FEED PUMP
COOLANT PUMP
COOLING TOWER

FIGURE 1